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Artificial Intelligence (AI) And Autism Spectrum Disorder (ASD) Literature review

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Abstract – This article presents a broad writing survey of innovation based intervention systems for individuals confronting autism spectrum disorder (ASD). Investigated approaches include, "computer vision assisted technologies(CVAT), contemporary computer aided systems(CAS), and visual reality (VR) or artificial intelligence (AI) - assisted interventions ". The research over the previous decade has provided enough showings that individuals with ASD have a strong interest in innovation based interventions, which are valuable in both, clinical settings just as at home and classrooms. Regardless of showing extraordinary guarantee, research in fostering a trend setting innovation based intervention that is clinically quantitative for ASD is minimal. Also, the clinicians are not persuaded about the capability of the technology based interventions because of non-observational nature of distributed outcomes. A significant explanation for this absence of agreeableness is that a greater part of studies on distinct intervention methodologies don't observe a particular guideline or research design. We concluded from our findings that there stays a gap between the research community of computer science, psychology and neuroscience to foster an AI assisted technology for individuals experiencing ASD. Following the improvement of a standardized AI assisted interventional technology, a data base should be developed, to devise effective AI algorithms.

Keywords – Computer vision assisted technologies(CVAT), Computer aided systems intelligence, and Virtual reality. (CAS), Autism spectrum disorder (ASD), Facial expression recognition, Artificial intelligence.

I. INTRODUCTION

Facial expression plays a vital role in our daily lives and our everyday social settings. Facial expressions are a compelling type of nonverbal communication and gives a signal with regards to emotional states, mind sets and intensions [1]. Facial expressions alongside verbal signs ordinarily let us get what an individual truly understand. Human beings follow a similar pattern of development in terms of physical and mental capacities and furthermore during the development of basic facial expressions [2,3,4]. Normally developing individuals decode life expressions of others with whom they interact, and then they behave accordingly [5].

Deficits in facial expressions can restrict an individual's ability to connect with others and affect negatively on health and quality of life [6,7]. Deficits under specific medical conditions like ASD can likewise affect social abilities, communications with others just as the perception of expressions. Similar is the situation with individuals facing autism [8].

Neurodevelopmental disorders, for example, ASD are connected with bridged capacity to produce [9] and perceive [10] facial expressions [11]. Characterizing measures for autistic disorders, are abnormalities in social interactions, verbal and non-verbal communication impedances and a restricted scope of interests and activities. Verbal social hindrances include deficit in social interactions, for example, managing ordinary conflicting scenarios communicating with people [12]; dealing with people in the

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society, language and reading skills, unconstrained greetings to peers. While non-verbal communications impairment includes deficit in facial expressions. physiological changes [13], maintaining eye contact and decision making to cater these deficits and disruption of recognition of facial expression, computer scientists are attempting to improve the skills and perception of these individuals facing ASD, by technology, for example, computer vision assisted technology (CVAT), and computer aided systems (CAS) used in making serious games [14, 15, 16,17].

As per the British machine vision affiliation (BMVA), computer vision is the science that intends to give machines their eyes and brains to see and envision the world. It is concerned with the automatic analysis, extraction and understanding of data as biometrics [18], character recognition [19], forensics [20], image restoration [21], medical image analysis [22] as well facial expression recognition [23].

Scientists contemplated and used automatic expression recognition algorithms to help individuals having ASD by intervening in social skills, expression recognition and production of expressions e.g. by serious games [16,17, 24, 25]. It has been theorized that technology is independent from tendency towards somebody depicting maladaptive behaviours and is simply, whoever is utilizing it. While humans (therapists) will generally build up maladaptive practices unintentionally making the outcomes be not concrete or not exactly true to make conclusions. Maladaptive behaviours are practices that are generally and most frequently used to lessen the individual anxiety, however the outcomes are dysfunctional and non-productive. For example, keeping away from certain situations since you have unreasonable feelings of fears may for now decrease your anxiety, yet it is non-productive in easing the actual problem in the long term. [26]

Autism spectrum disorder (ASD) is a life-long developmental disorder influencing social and communication abilities of individuals and affects the life of their relatives, and the symptoms of autism are more visible and simpler to distinguish in children 2 to 3 years old [27]. One out of each 68 children has autism in the USA. Thusly, diagnostic methods have been created to distinguish autistic traits in its primitive stage to promptly give the necessary health support and services [28].

The diagnosis for ASD can be troublesome since there are no typical medical tests, similar to a blood test, to diagnose ASD. To begin the diagnosis process, general practitioners(GPs) frequently screen cases for the chance of autistic traits and afterward refer potentially positive cases to specialised psychologists or psychiatrists for additional behavioural assessment. The ASD diagnosis can be started on toddlers aging 18months or older, in spite of the fact that getting a final decision might happen at later age [29]. The ASD diagnostic process requires clinical experts to direct a clinical appraisal of the person's developmental age based on a variety of categories (e.g., Behaviour excesses, communication, self-care, and social skills). This broadly acknowledged methodology is alluded to as clinical judgment. There are common diagnostic instruments for ASD like Autism Diagnostic Observation Schedule (ADOS) and Autism Diagnostic Interview-Revised (ADI-R) in which multiple questions and activities might be assessed by the diagnosticians during the diagnostic process. Moreover, an early diagnosis is likewise important for neuroplasticity, which is larger when children are younger.

Notwithstanding the adequate degrees of exactness and validity of clinical diagnosis techniques, they have been criticized of being time-consuming, having massive numbers of questions, utilizing a static basic scoring function for generating autism score, and requiring specific clinicians to regulate the cycle among others [30,31]. In this way, researchers at the exploration spaces of applied behaviour science and psychology created screening strategies dependent on the clinical diagnostic methods like Modified Checklist for Autism in Toddlers (M-CHAT) and Autism Quotient (AQ) to possibly diminish the waiting time for potential individuals on the spectrum and their relatives [32]. Nonetheless, since most screening techniques are based on clinical diagnostic methods, they acquire a considerable lot of their insufficiencies, for example, having an enormous number of items in the questionnaire and poor accessibility for non-specially trained professionals. [33]– [36].

II. Existing Mobile Screening Applications for Autism

ASDTests: ASDTests is a multilingual mobile application for identifying autistic traits in various age categories. This application depends on various conventional screening methods including AQ-Adult-10, AQ-Adolescent-10, AQ-Child-10, and Q-CHAT-10. The application adopts the classic scoring functions of the previously screening methods; it yields the choice of whether a case is associated with autistic traits. The goal of ASDTests was to gather information identified with autism to improve the performance of the screening system. ASDTests don't utilize any intelligent machine learning algorithm in predicting the possibility of autistic traits rather it utilizes conventional rules and scoring functions developed by conventional screening methods. The application comes in ten different languages, and it has high rating. [37]

Awesomely Autistic: This is a mobile application that contains multiple choice questionnaire for screening autism. The fundamental point of the application is to foster a simple autism screening mechanism. This application can be utilized by general practitioners for referring patients as an evaluator of autism utilizing the conventional AQ screening questionnaire. The Awesomely Autistic application is accessible in multiple languages. [37]

Autism Test: Autism Test is one more mobile application to detect autism for all age groups. Utilizing a screening method, this application comprises 20 questions related to feelings and tasks, however it is obscure what mechanism is applied to plan the questions. The result of the test is the autism probability level that the subject has developed. [38]

Autism and Developmental Disorder Screening (ANDDS) application: This screening application's aim is to assess whether children under three years and infants 6months old or, more exhibited autistic traits. The parents or clinicians can utilize this application by answering a series of yes/no questions covering the child's behavioural aspects as different phases of their age [i.e., 6, 12, 15, 18, 24 months, and three years]. Then, at that point, the application offers the result of the separating three different bands groups dependent on the given answers in which green demonstrates that the child is normal in terms of behavioural development, yellow shows that parents should watch the progress of their kid's behavioural development, and red pinpoints that further clinical assessment is required for the kid. [38]

ASDetect: ASDetect is an autism screening application for new-born children aged somewhere in the range of 11 and 30 months. The development of the application centres around making positive result on children with ASD. ASDetect contains three classes of screening dependent on the child age [12, 18 months, and two years]. The authors of the application guaranteed that the screening precision arrived at 81% when compared with traditional screening, yet this has not been checked by independent studies. [39]

Up to this point there is no all-around acknowledged treatment, intervention or cure for ASD. In any case, there have been various cases announced where intensive behavioural and educational intervention programs significantly improve results for individuals in the long term [40,41]. To the best of our insight, no empirical generalized outcomes have been concretely reported at this point, in spite of the fact that there are studies on which show positive and convincing results in post intervention results [42]. There is urgent requirement for intensive treatment strategies for individuals facing autism. In any case, suitable intervention, resources and therapeutic medicines are difficult to get or are simply too expensive. For this explanation, CAS are being used to make automated and effectively easily accessible systems to cater the needs of individuals having ASD [43].

Some previously done studies on ASD [44,45], give proof that CAS medicines are more robust on those individuals that don't faces over mental abnormalities, as HFA (High Functioning Autism) and AS (Asperger's Syndrome). (Table 1) [46].

III. Brief description of Pervasive Developmental Disorders (PDD)

Autism is characterized utilizing behavioural criteria, since so far no genetic markers are known. The characteristics vary significantly in severity just as in combination, inside and across individuals, just as with time [47]. Aside from AS or HFA; the subgroups of autism are the terminologies used to describe the higher functioning end of the mental autism spectrum. AS correspondingly with HFA is a more up to date term as it was perceived later on, in early1994. At present, every one of the terms have been converged under a solitary umbrella called autism spectrum disorder (ASD). Since we have characterized and overviewed all the researches beginning around 1973 every one of the terms are referenced completely as indicated by the DSM-IV rule and the Autism Society of America. Due to previously mentioned affiliations and the extension in the spectrum, the criteria has prompted a dramatic increase of ASD. Subsequently, mental imbalance isn't any longer a rare disorder [47,48].

Table 1 Sub-classes of pervasive developmental disorders(PDD). This table is motivated by writing introduced in the DSM-IV and studies revealed by autism society of America (ASA)

Pervasive Developmental Disorders (PDD)	Autistic Disorder	Qualitative impairment in social interaction, communication (delay or lack of development of spoken language) and restricted, repetitive and stereotyped patterns of behavior, interests, and activities categorized by substantial difficulties in social interaction, non-verbal communication skills
		High Functioning Autism (HFA) is a term applied to people with autistic disorder who are deemed to be cognitively "higher functioning" (with an IQ of 70 or greater) than other people with autism. Individuals with HFA may exhibit deficits in areas of communication, emotion recognition and expression, and social interaction.
		Low Functioning Autism (LFA) refers to autistic people with cognitive impairments. Symptoms may include impaired social communications or interactions, bizarre behavior, and lack of social or emotional reciprocity. Sleep problems, aggressiveness, and self-injurious behavior are also possible frequent occurrences
	Asperger's Syndrome (AS)	Qualitative impairment in social interaction, restricted repetitive and stereotyped patterns of behavior, interests, and activities; no clinically significant general delay in language or cognitive development. Generally have higher IQ levels but lack in facial actions and social communication.
	Rett's Disorder	Development of multiple specific deficits following a period of normal functioning after birth. Deceleration of head growth, loss of previously acquired purposeful hand skills, loss of social engagement early in the course of life. Appearance of poorly coordinated gait or trunk movements. Severely impaired expressive and receptive language development with severe psychomotor retardation.
	Childhood Disintegrative Disorder	Marked regression in multiple areas of functioning following a period of at least two years of apparently normal development. Expressive or receptive language; social skills or adaptive behavior; bowel or bladder control; or play or motor skills
	Pervasive Developmental Disorder Not Otherwise Specified (PDD-NOS)	Severe and pervasive impairment in the development of reciprocal social interaction or verbal and non-verbal communication skills and stereotyped behaviors, interests, and activities.The criteria for autistic disorder are not met because of late age onset; atypical and/or sub-threshold symptomotology are present.

AS incorporates individuals who have fluent language and better academic abilities alongside obsessions and narrow interests, however they have limited facial expressions and damaged recognition just as interpretation of emotional perceptions [49]. Children having ASD face problems associated with communication and usually misinterpret by relying upon exacting, as opposed to the context oriented significance of words [42]. Such kids likewise deal with different issues like fits and self-harmful affiliations. This criterion has been settled upon around the world by specialists and clinical professionals. [50,51]

Population statistics depict that autism is a quickly arising formative inability in the United States, with an expected yearly cost for finding, and treatment of 90 billion USD (Autism Society of America) [51]. Statistics likewise uncover that around 1% of the world's all population has autism spectrum disorder, as detailed by the Centre for Disease Control and Prevention (CDC) [39]. The complete population proportion of male: female is 3:1 This demonstrates that autism significantly and generally happens in males. It has additionally been expressed that mental abnormality, which implies IQ under 70 is unequivocally connected with autism and

is between 25 and 40% cases of ASD Comparably, aspergers syndrome (AS) is assessed to influence at a considerably higher male: female proportion, going from 4:1 to 10:1 [53,54].

The utilization of CAS/CVAT is being used by researchers and is similarly a cheap option for individuals and advisors. The usage of computer science in a joint effort with psychology in the treatment and reading of autism for research purposes was recognized almost immediately [54,55]. Nonetheless, just since the last decade analysts have been examining the utilization of CAS mapped with autism [56].

IV. Distinct CAS/CVAT based interventions

A question from the researchers that is being taken care of quite critically, is whether or not CAS really is more effective than traditional teaching methodologies. Researchers have announced positive results however just as far as statistical influences [54]. Some remarkable studies have specifically tended to the subject of the efficacy of CAS over traditional approaches [45] with individuals facing ASD [57,58].

Whether or not CAS is superior to traditional methodologies as far as proficiency or not, CAS can be given preferences over traditional methods since it may be simpler with CAS to devise medicines with limitless repeats, more noteworthy accuracy and lesser variability subsequently, guaranteeing higher treatment fidelity. This would likewise make it conceivable to connect far off regions at a larger scale by saving expense, because of automation. Alongside diminished requirements for exceptionally qualified and prepared, costly, administration giving experts, this additionally clears way for larger rate of diffusion of treatment, training and education. We can likewise recognize that CAS compared with human interventions is more effective on the grounds that the helper or the attendants in human instructed sessions can initiate maladaptive behaviours accidentally while giving individual more consideration.

In the facial expressions based interventions we have sub divided the categories into interventions that target non-verbal communication skills for example facial expression, emotion recognition, maintaining eye contact, decision making, etc. Verbal social skills for example social interaction like managing ordinary conflicting situations, speaking with individuals, managing individuals in the general public, language and reading skills, unconstrained good greetings to peers, etc. Computer generated reality/Augmented reality for example technology teaching both verbal social skills and non-verbal communication skills in an Augmented Reality based CAS/CVAT interventions. [57,58]

V. Non-verbal abilities

Communication with people is more than what a person has to say or the messages given by physiological changes and facial expressions. This incorporates implied messages whether purposefully or inadvertently which are communicated through non-verbal cues. Non-verbal communication incorporates facial expressions, the tone and pitch of the voice, gestures, non-verbal communication (kinesics) and distance between the communicators (proxemics) however the primary centre lies with the expressions of the face.

Seven-teen people (aged4–14yearswithmean age 8 years 2 months) out of which 6 people had ASD. People were engaged with both human and computer instructed sessions in an alternating treatment design which consisted of judgemental assignments. The displaying video was faced by a two key plexiglass response panel that separated the screen down the upward midline [63]. The apparatus was arranged in a medium measured sound lessened room enlightened by florescent bulbs (2 × 15W). It was theorized that CAS sessions are equally officious to human instructed methods which was in opposition to the past studies, however as indicated by the cases of the authors, the justification for this efficacy was top-notch of the speech synthesizer, created/customized to deliver verbal directions for the individuals [60,61,62].

Balçın et al, contrasted PC and human-instructed tasks with four individuals' age in the range of 4 and 7 years with ASD, to see indecently chosen tasks. They fostered an enthusiasms cale to assess whether CAS was more amusing than conventional human educated system. Additionally, assessing whether CAS brought about a superior errand execution comparatively Like speculated improved inspiration in individuals utilizing CAS [60,64].

Davis-Temple et al., presented "Teach Town" a self-paced and reward game, which consolidated standards of Applied Behaviour Analysis (ABA) for correct responses. The lessons focused domains like cognitive skills, social and life skills just as receptive language skills. Studied individuals with ASD specifically to quantify the efficacy of Teach Town: Basics—an educational CAS

that included computer lessons and day to day environmental activities that include standards of ABA. The individuals were trained in a particular preliminary format with a support on correct responses in a (timed) animated game followed by verbal praise and graphics, close by human instructed approach. individuals got every day lessons on the CAS for twenty minutes around and a same physical activity session as a feature of the Teach Town CAS protocol. Total47 childhood individuals with ASD aged 3–6 years were involved. The review announced enhancements in responsive language and social abilities following two months of preparing with "Teach Town"- CAS. A several limitations were accounted for as certain educators didn't follow the appropriate educational program, information was not gathered from a specific timeframe as it was not auto logged, and very limited time was spent on the CAS. [58]

Silver and Oakes et al., worked on progress and comprehension of emotions in individuals with ASD and like the "Emotion Trainer" CAS. one grouping involving eleven individuals (children) got CAS training whereas the other grouping (control group) attended as a non-CAS (for example did not get the intervention) containing eleven individuals(children) [65].

The CAS is effortlessly understood by compartmentalizing it into five sections: the first section is to identify emotions (for example happy, sad, angry) from facial expression; The second section showed cartoon characters with a label depiction a scenario. The scenario would provoke emotional expression e.g., a rabbit image, marked "Mary's pet rabbit died" and incited whether or not the state of affairs would satisfy Mary, sad or afraid. The third section showed an image of what someone needs and what expressions would be if they received something else, completely different separated from what they require as an example "Josh desires a dish, but gets a sandwich. currently whether or not that made Josh happy or sad. The fourth section is just like the second section however addressed mental states instead of the physical events. Section five showed an incident and asked if it absolutely was liked or disliked. at some stage in the sections, correct reactions were granted by compliments "well done" showed on the screen. Careful reportable applied statistical improvement in Sections, two and four of the CAS. However, no important enhancements for facial expressions were reportable. [66]

Bölte et al., planned and evaluated a CAS named FEFA to arrange train basic facial expressions recognition skills to individuals with ASD. Study used ten (male) individuals with HFA/AS, aged16–40 years. The members were haphazardly separated into two gatherings, N = five to a gathering that may take the CAS intervention. whereas the other control group, N = five were assessed while not intervention. a thousand photos of properly distinguishable expressions of females and males were gathered from people of varied societies [67]. These incorporated the photos of facial affects have an effect on from Ekman et al., the images were altered all the way down to show the eyes instead of the whole face for recognition of expression for a selected modality [68].

For rating the photos, various plan of general elementary feelings Ekman and Friesen, was picked as reference. 2 tests were planned, initial during which a complete face with an expression representation with decisions of what's the individual inclination straight away. whereas the other showed a cut image of the eyes with similar decisions of however was the individual feeling. for proper reply, a feedback was accomplished with smile about to the proper reply. If the individual selected some unacceptable reply, the proper answer is shown aboard the clarification [69]. The comics used were from "Teaching kids with syndrome a way to mind read" [70]. Still, the commitment of CAS with people having ASD would possibly ought to be instructed specifically [71]. (Bölte et al., believe that the coaching module haven't considerably contributed towards the meant behaviour modification in existence of course by authors [72].

Bölte et al., reportable that the impact of CAS is to impart facial affect recognition whereas noticing neurologic structures by functional resonance Imaging (fMRI) of people with ASD. Ten members were enclosed within the study, out of that five were management group and also the different five were within the intervention group (mean age 29.4 years) [73]. The functional magnetic resonance imaging scans were created before and once the experimental group had more experienced the CAS intervention section. FEFA/CAS was accustomed train and assess the facial expressions (basic emotions). No important activation changes within the fusiform gyrus (part of the temporal lobe and occipital lobe—brain) was observed by functional magnetic resonance imaging [72].

Though trained members showed activity improvement whereas in depth improvement within the basic recognition of emotional skills was reported. As limited individuals were present for the study thus no generalization might be created and this was accounted for as a limitation well. Moreover, there was no experimental data to indicate the clinical significance and generalization of those effects [72]. Moore et al., developed a CAS as visual representations of facial expressions with a “symbol”.

TheCAS permissible illustration of looks andanimatedsequences transfer emotional situations. The symbol showed four selective expressions: happy, angry, unhappy and worry. The study was directed in 3 distinct stages. within the initial stage, the individuals were requested to acknowledge expression from the symbol, by selecting the corresponding reply-representation. In stage 2, the individuals foreseen the expression in numerous situations. whereas in stage 3, individuals were shown a symbol in a situation communicating an emotional expression and were asked to decide on that event(s) caused the expression. analysis of the data was finished by typically scrutiny the whole determined responses with the complete reactions expected just in case they were chosen by some coincidence. The author reportable that 90% of the people World Health Organization participated, had the choice to acknowledge, anticipate and interpret the symbol's emotional expressions. Also, they inferred that this CAS strategy permissible the kids to effectively communicate with others [74].

Golan and Baron-Cohen, completed 2 experiments during which people were ready with the "Cambridge Mind Reading" CAS to acknowledge expressions in different human faces. The core plan of the CAS, was countenance recognition and audio expression recognition succeeding showing or taking part in a countenance video of 3–5 seconds or audible clip of an emotional intonation in words. succeeding observance, the countenance clip or the audio, the members would lean four descriptors and requested to "pick the word that best describes how the individual is feeling". To make sure that the ideas were chosen from the adult emotional vary, they were chosen from the upper levels of the scientific categorization; The model to boot contained 412 distinctive ideas, that were grouped into twenty-four fundamentally unrelated groups like angry, happy, sorry gathering, etc., whereas utilizing these scientific classifications aboard visuals and audible upgrades [75]. Baron et al. created a knowledge base of actors of each genders of varied age and identities. The "Mind Reading" CAS locations to survey the wide scope of emotional expression and to measure each facial and audible modalities. An additional careful knowledge is gotten from Baron-Cohen et al. [76].

In a geographical region and Baron-Cohen [77] explore, a total of sixty -five people participated. Out of sixty-five people, forty-one members (mean age of 30.5 years) were facing HFA/AS and having a verbal IQ and performance IQ of 108.3 and 112 separately, twenty-four experiment participants (mean age of 25.3 years) were generally developing people having verbal IQ one 115.8 and performance IQ of 112.5. The comparison between intervention and non-intervention of "Mind Reading" CAS was directed aboard the correlation of AS/HFA people across three levels. (75)

Lacava et al., used "Mind Reading" CAS to indicate eight people (children aged between eight and eleven years) with Asperger's syndrome(AS). Out of eight kids, six were males and 2 were females [78].

Lacava et al. reportable important enhancements in children's' capability to acknowledge basic to advanced feelings. Another positive perspective careful was, the people collaborating within the examination found the CAS additional pleasurable and entertaining instead of the standard and standard techniques. people showed improvement in working the CAS. In another trial, Lacava et al., used "Mindreading" CAS to assist four people with HFA to acknowledge the essential to advanced feelings delivery concerning positive results as an example improvement the popularity but no substantial results were created [79].

Faja et al., determined that CAS based mostly face preparing will influence process of faces. It was seen that7–10h of CAS based mostly facial preparing brings concerning sensitivity to comprehensive face handling. In Faja's trial ,5 young adults with HFA–ASD having mean age of 19.0 years and a full scale IQ of 99.0; got preparing to differentiate faces as indicated by sex, chorological age and identity. Following three weeks of preparing, post-intervention results uncovered that the trained group exhibited bigger sensitivity to configurable knowledge as an example distance in between of the eyes somewhat to the undeveloped part. This depicted that character of recognition skills is worked on through preparing in recognition of the face. In any case, this technique had a many limitations like tiny sample size, completely different age reach and incorporation of people with HFA. we have a tendency to infer that generalization cannot be created for treatment of face handling from Faja et al., as adequate knowledge is not accessible [80].

Beaumont and Sofronoff, looked at a treatment group and a control group measured on facial expressions, social competence and comprehension of understanding emotional management systems. Beaumont et al., fostered a CAS called the "junior detective training" which included three levels. First level encouraged individuals to interpret facial expressions alongside body postures, just as prosody of speech of a CA managed human like character. The subsequent level worked with individuals to interpret the feelings of cartoony characters in decode emotions utilizing non-verbal signals. The third level gave the individuals to utilize those learned social skills to be used in a visuals reality (VR) environment. Post treatment results portrayed statistical improvement

comparatively from the control group. Two statistical improvements reports were concluded: parent's report and an educator's report. The reports were questionable in light of the fact that it couldn't be assessed whether they demonstrated clinical perspective [25].

Tanaka et al., evaluated facial expression processing with an educational plan based, experimental measure called the "Let's face it!" (LFI) CAS [81]. The proposed measure was made out of seven sub-tests (game modes) that depended on the perception of facial identity over a wide scope of face processing tasks defined by Wolf et al. The seven modes were, parts coordinating to complete faces; recognize changes in face dimensions; recalling/memorizing faces; face matching with masked features; face matching of same person with different expressions; distinguish changes in dimensions of a house and recalling/memorizing cars. [82]

A 117 (individuals/participants) facing ASD, from which 79 children, adolescents and young adults were included in the study, and were randomly divided into two groups, active treatment and a wait list group. The active treatment group composed of 42 members (34 guys and 8 females) were dissected out of 65 with a mean period of 10.5 and a mean full scale IQ of 93.6 while the standby list group had 52 participants out of which 37 (28 males and 9 females) were examined with a mean age of 11.4 years and a mean full scale IQ of 95.9. The main sub-test revealed was to be parts/Whole identity for example parts matching to complete faces dependent on the "Let's face it!" CAS. Participants results for treatment varied significantly only on the test for matching with parts to whole faces [82].

Cockburn et al., created "Smile Maze", an expression production recognition CVAT to enhance skills of children progressively, and made engaging in by a game format [83]. The computer recognition expression toolbox(CERT). Bartlett et al., is the backbone utilized for the "Smile Maze"[63]. It is similar to a Pacman game Khenissi et al. [84] (look wise) while the principles are not quite the same as a Pacman game. The user or player is a pacman (sprite) which is navigated by the keyboard keys while other, expressions imposed sprites (for example happy/smiling) [84]. No interaction, study or testing at all of the system of individuals of ASD was accounted for. Cockburn et al., additionally analysed their CVAT with "let's face it!" (LFI) CAS, however, no significant correlation was done as the LFI just gives recognition and not the production of facial expressions [83].

Golan et al., designed an animated series named "The Transporters" to improve the facial expressions just as emotional vocabulary. The Transporters depends on eight characters who are vehicles that move by a standard based methodology. While on the vehicles were real human faces of actors showing changed facial expressions which were really forced. These vehicles were then used in a topical short storyline situation e.g. Charlie is feeling content with a vehicle having a face of a human showing happiness, after that showing different vehicles having faces, to choose who else is feeling happy?" [85].

Hopkins et al., tested their intervention named "Face Say "CAS. "face Say" contains three distinct modalities with a symbol designed to teach social abilities to individuals having ASD. The symbols were animated photographs of genuine people while the motto of the games was to promote eye gaze, facial expression recognition and face recognition. The first methodology was to go to eye gaze. The symbol was surrounded by various objects. The individual was asked to touch the object where the symbol is gazing towards. Right reactions show appreciation. While the subsequent methodology was intended to show face recognition. The player was asked to choose the appropriate fit for that distortion present on the symbol's face. While the third methodology was to perceive the eye movement [86].

Tsai and Lin, utilized CVAT named "Face Flower" to help ASD individuals to improve on non-verbal (facial expressions) by using a flower to grow by the user's (individuals with ASD) facial expressions. The intention was to help individuals to pronounce their facial expressions and practice their expressions and facial muscles to a specific muscles to see the plant grow. The CVAT was controlled through the facial expressions of the individual. The facial expression detection tracking and feature extraction was done utilizing eMotion software that classified the expressions dependent on facial feelings defined by FACS [88]. eMotion is a method for creating interactive motions of objects for visual performances. Anyway there wasn't any trial done on any example size through which results could be concluded [87].

The facial action coding system(FACS) is a detailed structurally based course of action for estimating all visually apparent facial movements. FACS defines all visually special facial activity dependent on 44 unique activity units (AUs) alongside multiple classifications of head and eye placements and movements [88]. FACS methods additionally consider the coding of the intensities of every facial activity on a scale of 1–5-point intensity [89].

Faja et al., concentrated on the skill as a result of training faces in adults facing ASD and those showed initial impairment in face recognition. The authors reported the outcomes of study in which the individuals who participated were randomly grouped into two. First group was to take computer training including faces and recognizing the properties concerning such as gender. The other group was shown houses and requested to describe the shape of the house. The authors assessed that participants in face recognition and participants in house recognition, both showed improvements for measures of memorization of the faces and houses [90].

Jain et al., proposed a CVAT for ASD which joins domains of computer vision and computer graphics. The CVAT tracks facial features and uses those features in the recognition of facial expressions of individuals [91]. The system was worked to perceive six basic/universal expressions for example anger, disgust, fear, joy, sadness and surprise [92]. These tracked features were additionally used to animate a symbol which in the long run mimics person's expressions. This was refined by locating and tracking facial features [93].

VI. VERBAL SOCIAL ABILITIES

Verbal social abilities are characterized as there is a high union of verbal inflection and nonverbal facial expressions while communicating. For example, when an individual is fearful, his voice shakes and the fear can be seen by their facial expressions just as their voice. However, the CAS that was planned specifically for sound or voice training or teaching communication are not part of this study. In any case, the facial expression CAS training or analysis that has voice training and also takes into account the verbal social skills are incorporated and discussed.

Social skills are the skills we use regularly to interact and speak with others. Social skills are essential in engaging an individual to have and keep up smooth interactions.

A considerable lot of these abilities are basic in making and maintaining relations and associations. Social interactions don't generally run as expected yet an individual's requirements to execute appropriate strategies, for example, settling conflicts when issues in interaction come up. People must have "empathy"(i.e. Having the ability to put yourself in to someone else's shoes and see their opinions) as it empowers them to respond in an agreement and disapproving of way to deal with how others are feeling.

Simpson et al., planned a CAS to instil social skills to 4th grade-schoolers matured 5–6 years. All individuals had lack of social skills and were confronting mild to severe, language and speech impairment. They planned a CAS consisting of video clips of typically developed individuals portraying a few examples of target conduct like sharing, following instructions of an educator and social greetings. The authors likewise assessed the grade-schoolers unexpectedly in vivo generalization sessions. In these sessions, the individuals typically interconnected with control developing children. The post intervention gave improvements in the targeted social skills however specific component analysis was impractical as they utilized a multi-probe design across all the behaviours. Hence, authors can't evaluate which specific aspect of treatment was responsible for the improvements [94].

Whalen et al., introduced "Teach Town" a self-paced lessons and reward game, which incorporates principles of applied behaviour analysis for correct responses. The lessons focused on areas like cognitive abilities, social and life abilities just as open language skills [95].

Nikopoulos and Keenan, utilized video demonstrating in two tests as CAS including two of baseline designs. Four individuals with Autism were shown social arrangements consolidating social initiation reciprocal play, imitative reactions, and objective management. Tapes were displayed to individuals concerning the social skills acting as a marker for each target behaviour. Each individual observed all the video-clips and were allowed to go in where individuals were confirmed by a group of individuals for social interactions. The authors revealed positive outcomes proving video demonstrating to be productive and effectively assisted individuals with ASD [96].

Lacava et al., utilized "mindreading" CAS to show eight individuals (children) with AS having age 8–11 years (6 males and 2 females) to distinguish the basic to complex emotions. The authors concluded significant enhancements in verbal social skills and non-verbal social skills. Another beneficial effect that was accounted for was, the individual taking part found the CAS or computer intervention more fun and entertaining rather than the traditional and regular conventional ones and showed improved skills in operating working the Systems [78].

Beaumont and Sofronoff, planned a CAS named "Junior Detective Training Program" which incorporated a detective themed storyline alongside with goals and awards at the succession of a task which accumulate at the end. They increased levels of difficulty as individual push forward in the CAS. individuals were approached to recognize emotional responses and then label correct reactions for the characters in multiple settings. 24 adolescents with ASD were included for the study while the intervention group exhibited an increase in pre-assessment to post-assessment results [25].

Sansosti and Powell-Smith, utilized spatio-temporal evolution of pictures as Simpson et al.; Nikopoulos and Keenan, CAS in which social skills were Instructed to the individuals Like participate, greetings and sharing. The CAS included video demonstrated social stories to represent right friendly practices. Three individuals with HFA participated in the study. The authors detailed CAS joined with spatio-temporal evolution of pictures to increased frequency of the targeted behaviours. 2 weeks' intervention was applied to the individuals inside an educational environment and the follow up after showed that every individual had the option to maintain the learned targeted behaviour/communications skill. Spatio-temporal evolution of picture or video modelling isn't really CAS/CVAT however an essential part of it, which is the reason it is included to address it as an underlying advance towards development of an efficient CAS/CVAT. Video modelling has been used to expand recurrence and diversity of social practices, and in a perfect world a significant part of a child's social collection ought to involve non-single social play, for example play including no play of what one individual other than self. A large portion of these studies show evidence that video modelling can build or train an individual of some target social skills. Target practices for treatment will be picked as, for the individual's shortages, including marking of feelings, free play, unconstrained welcome received, talked dialects appreciation, conversational talk, co-agent play, step by step living aptitudes and social play [97,98,99].

Grynszpan et al., developed a CAS in a pre-post evaluation design. The first modality of the pre-plan period of the CAS called "What to Choose?" provoked the player to pick one of the three assertions about a dialogue scenario from which one declaration would be true for example Carole had a test today and the educator is away. A friend let Carole know that the test is cancelled. How might Carole feel about this? A facial expression of a human like character is additionally endured the dialogue to make it simpler to decide how Carole is feeling in regards to the scenario/dialogue. The characters depended on Ekman's guidelines [100].

Ekman planned with Poser, the second modality of the CAS called "Cartoon Characters". Cartoon characters was like the previous one however the human like characters were supplanted with cartoonic characters in this methodology to prove which one would be favoured or considered toward. Though it did not seem to produce any differences in the performance. While the third module named "Faces" was likewise evolved which was to exclusively perceive the facial expressions. A facial expression picture was shown alongside 6 potential decisions for example (Happy, Sad, Angry, Surprised, Frightened, and without emotion) and the player had to choose one of the six emotional expressions stated. Then again, post-design CAS presented a similar pattern, and called it "intruder", yet with different content. The post-assessment surveyed member's capacities of learning transfer and the acquired skills through training to a more complicated task, including similar cognitive skills. As underscored by Loveland, the ability to connect apparent feelings with a non-still social context is viewed as impaired in autism [101,102].

The training lasted for a period of 90 days, comprising of thirteen sessions. Two groups were made which were coordinated by age and scholastic level. A clinical gathering which included ten young men with HFA and having a normal sequential time of 12.10 years. A benchmark group which included ordinary ordinarily creating people filled in as a source of perspective base for the clinical gathering. The normal IQ of HFA people with the WISC-87 (Wechsler Intelligence Scale for Children) was 80.5. Results after assessment of members with mental imbalance conjectured that their learning move was not really basic contrasted with a straightforward and a rich interface. While the post evaluation results exhibited that the clinical gathering worked on just with the straightforward interface. Thus, the rich interface probably hampered learning moves for the clinical group [101].

Lacava et al., trained four children with HFA to recognize the basic to complex feelings and to measure their social behavioural skills resulting in positive results for example upgrades in the recognition but with no quantitative conclusion [79].

Whalen et al., directed a large scope study on 47 people with ASD aged 3–6 years. The study reported improvements in responsive language (object recognition) and social abilities (expression recognition and perception) following two months of training with "Teach Town"- CAS. To measure potential of CAS for learned social skills, Hopkinsetal., tested their intervention named "Face Say" CAS with a group of HFA and LFA. 49 people (24 HFA and 25 LFA) having IQ of 91.9 and 55.1 respectively were involved with "Face Say" CAS intervention that targeted social skills [86]. Individuals with ASD aged 6–15 completed twelve

sessions over the period of 6 months with the CAS. Relating to the control group the intervention showed improved social interactions and behaviours with peers which was noticed while they interacted with each another in a playground [103].

VII. VISUAL REALITY/ AUGMENTED REALITY

Visual reality (VR) gives a system to simulate true world scenarios utilizing computer vision and computer graphics. Along these lines, VR technology permits educators and therapists to offer a safe, repeatable and diversifiable environment during learning for individuals facing ASD. Artificial intelligence (AI) instils human-like senses and gives realism close by stimulus or environmental control, which works with situation creation needed for learning in ASD intervention/treatment. VR advances have exhibited potential for learning and assessment of children, and adults with a mental imbalance [104].

Moore et al., utilized VR as a CVAT changing the technological mechanism of CAS for ASD. They utilized emotional facial expression recognition with an anthropological 'symbol' for individuals of ASD. The CVAT allowed representation of facial expression and animated sequences conveying emotional situations. The avatar showed four exclusive expressions happy, angry, sad and afraid. The study was directed in modular fashion. In the first module, individuals were requested to recognize expression from computer produced symbol. Second module was expression prediction. While, third module was intended to test/improve individual's skills in anticipating occasion that causes various expressions. Analysis of the information was done by somewhat comparing the total noticed reactions with the complete reactions expected in case they were chosen by some coincidence. The author detailed that 90% of the individuals who participated, had the option to recognize, predict and interpret the symbol's emotional expressions. Besides, they reasoned that this CAS strategy permitted the kids to adequately communicate with others [74].

Parsons et al., measured the behaviour of two individuals(adolescent) with ASD, with the help of various VR settings. In the study, they confirmed that adolescents significantly interpreted the scenes and liked the chances to keep up a dialogue [105]. They additionally answered appropriately, despite the fact that they showed repetitive behaviour and interpreted the things virtually. Mitchell et al. [106] followed a comparable method of analysis, by developing a virtual cafe. About six adolescents with ASD aged 14–16 having a mean Verbal IQ (VIQ) of 81.9, Performance IQ (PIQ) of 87.1, and full scale IQ (FSIQ) of 83.1 [measured by WASI (Wechsler 1999)], were shown videos of real life scenarios going down in a bus or cafe in a virtual environment. The participants needed to give clarification of any place they had set to sit down and why for example by pointing towards a seat in a transport and concerning why that seat? The virtual environment was created with Super Scape Virtual Reality [107]. It was executed on a computer utilizing visualizer programming introduced in, Parsons et al. To notice the VR environment, a joystick or a mouse was utilized. While to choose object or person if one expected to communicate with an individual in the VR environment was utilizing a click of the mouse. Every one of the meetings were recorded for later study and assessment. The training went on for more than about a 6wks. The researchers hypothesized that there have been cases that made a decision about improvements, related with time spent inside the VR setting once choosing and explaining any place they chose to sit on the bus [104].

Fabri et al., put together their study with respect to how individuals with ASD interface with characters (symbols) which are fit for showing facial expressions like (happiness, sadness, anger and fear). Inside the first stage of the study, the participants, who were 34 children with ASD, having mean-age of 9.96 needed to pick the expression which was shown by the avatar. In the second stage, individuals needed to interpret what emotion the scene initiated while the avatar imitated it. In the third step, the individuals expected to pick what it was that caused the expression the symbol was communicating. The authors checked that thirty participants sorted out the feelings of the person and used them appropriately. While the excess four participants, had severe autism [108].

While Ke and Im, worked with computer visual reality environments including individuals with ASD in social situations. The primary task was to recognize the visual communication and facial expression of characters present. The second was to interact with them in a school canteen. Finally, interact with them at a party. Ke and Im [109] designated associated analysis dependent on perception of the individuals and the questionnaires. They obtained positive outcomes on the grounds that the children exhibited that communication and interaction all through the intervention had intensified as did their communicative abilities subsequent to playing out the tasks [109].

Strickland et al., devised a CVAT known as "Job TIPS" that made it achievable to show employment particularly interview related skills for adults' individuals experiencing mild ASD or HFA. They utilized visual aids, guides, recordings on the hypothesis of mind [110]. 22 youngsters were engaged with the examination to evaluate the productivity of the CVAT. Half of the individuals completed sessions though the other half made up the control group. The control group didn't utilize the CVAT. Post-intervention,

the individuals who utilized the CVAT showed significantly higher verbal abilities during the interview than the control individuals [110,111].

Kandalaft et al., planned a VR intervention to improve social cognitive skills of adults with ASD. There were eight participants with mean age of 21.25 and full scale IQ (FSIQ) of 111.88[112]. The individuals practiced scripted role-playing scenarios during an interaction basically with an online multi-player entertainment game alongside two facilitators (clinicians) to help, if necessary. The CVAT was planned by utilizing Second Life v2.1 (Linden Lab, a 3D virtual environment software accessible for public use. The CVAT included locations like office building, pool hall, a fast food chain, a tech store apartment, etc. While the training scenarios or skills targeted were social interaction with a friend, starting a discussion in a room, meeting strangers, negotiating in a store, giving a job interview, supporting a friend, etc. majorly targeting verbal and non-verbal skills. The avatars addressing the users in the VR world were demonstrated to look like the participants and were driven by standard QWERTY keyboard. All participants were trained with 10 sessions of VR training and showed slight enhancements yet upgrades were seen in all the targeted skills sets and the vast majority of the scenarios [113].

Serret et al., planned a somewhat different CAS called "JeStimule" which designated facial expression and gesture recognition through visual non-verbal codes which were introduced as colours and symbols [114]. Every essential feeling was related with a colours from Plutchik's emotional wheel (happiness = yellow, anger = red, disgust = purple, fear = green, sadness= light blue, surprise = dim blue), while pain and neural were related with black and white respectively, in view of a multi-sensory virtual reality environment. The CAS was especially intended for individuals facing LFA as there is no verbal text that need to be read and just controlled through colours codes that are related with emotions for instance red for anger. There were three degrees of recognition that exist: recognizing the emotion expressed by a virtual character because of a specific event (for example a child falls down), a similar task however the face of the virtual character isn't revealed, recognizing the emotion passed on by the non-verbal communicative behaviour of a character speaking with another character in which the verbal exchange is likewise inaudible. No conclusion and inferences from the statistical studies were reasoned that showed positive outcomes or improvements generically [115].

Cassidy et al., worked to model ASD individuals (adults) view of emotional expressions. Authors explored different avenues regarding seventeen adults and adolescents (two females and fifteen males, aged 14–21 years having VIQ of 89.6, PIQ of 97.0 and FSIQ of 92.2). Individuals were evaluated utilizing two conditions, for example dynamic and static. The CVAT included 21 video-clips of individuals showing facial expressions while getting a present (a box of chocolates, monopoly money, and so on) While the static stimuli were acquired by a single frame taken from every dynamic stimuli were shown on the Tobii 1750 eye tracker. Tobii studio was utilized to record eye movements. Complete details of the review can be acquired from Cassidy et al.

Results showed improvements in individuals with ASD in static conditions while not really significant in dynamics as stimuli is fast paced and individuals were facing difficulty answering accurately [116].

VIII. Conclusion

This study describes how individuals of autism spectrum range disorders(ASD) are handled by technology based intervention methodologies, which include: contemporary computer aided systems (CAS), computer vision assessed technologies(CVAT) and virtual reality (VR). Individuals with ASD have difficulty interacting with their peers, teachers and parents, and etc. Most of them like to connect with computers or augmented reality systems, which proves that technology based interventions can be an effective tool for improving the motivation behind instructing and learning facial expressions just as social skills. Most the technology based interventions are not intended to satisfy necessities of individuals suffering from ASD totally, as they have variable needs.

Major conclusions and future directions drawn from this broad writing overview are introduced below:

Generally, survey literature concluded much promise for CAS/CVAT interventions albeit none of the studies reported concrete evidence that it had the option to train or modify a complete behaviour of the selected individuals. Nonetheless, many studies detailed significant improvements frequently through statistical validations.

There is a need to plan an intervention technology that adheres to guidelines which is accepted to the clinicians as well as to the AI research community. An effort to standardize interventions technologies can be found in a new study in mechanical technology [117], while others suggested standards to direct the advancement of an effective CAS/CVAT [118,119].

There is a critical need to make standard audio/video database of individuals facing ASD. Without even of such database making artificial intelligence/machine learning algorithms is highly challenging. Secondly, the efficacy or robustness of published results remain suspicious or questionable.

Most of the researchers depicted their CAS/CVAT in a therapeutic or a clinical fashioned way. They showed their findings and observations yet don't intricate the architecture and design of CAS/CVAT thoroughly i.e. the manner in which an application is structured and what algorithms are defined and used in developing those CAS/CVAT w.r.t. computer vision (CV). While some researchers portrayed and elaborated the architecture w.r.t CV domain [83,87,91,93].

It is required to develop flexible intervention technology targeting the deficit skills in an individualized guidance setting. Planning an intervention technology, it is to be viewed the system design should deal with the common problems and cater the generic issues faced by individuals of ASD. Hence, developing a single that can work with variety of deficit issues.

Collective efforts are needed by the research community of AI, psychology research and neuroscience to develop an AI helped intervention technology for individuals experiencing ASD, to more readily see needs of the world. Researchers should focus on to remove the barrier and boundaries among disciplines and move towards a broader perspective of education and contribution towards scientific community by giving more essential and effective findings.

ABBREVIATIONS

(ASD): autism spectrum disorder

(CVAT): computer vision assisted technologies.

(CAS): contemporary computer aided systems.

(VR): visual reality.

(AI): artificial intelligence.

(BMVA): British machine vision affiliation.

(ADOS): Autism Diagnostic Observation Schedule.

(M-CHAT): is a scientifically validated screening tool that assesses risk for Autism

Spectrum Disorder (ASD) in children aged between 16 and 30 months.

(AQ): Autism Quotient.

(HFA): High Functioning Autism.

(LFA): Low Functioning Autism.

(PDD-NOS): pervasive developmental disorders not otherwise specified.

(ANDDS): Autism and Developmental Disorder Screening.

(ABA): Applied Behaviour Analysis.

WISC-87: (Wechsler Intelligence Scale for Children).

DSM-IV: codes are the classification found in the Diagnostic and Statistical Manual of Mental Disorders, 4th Edition.

(PDD): pervasive developmental disorders.

(CDC): Centre for Disease Control and Prevention.

IQ: *Intelligence Quotient.*

(fMRI): functional resonance Imaging.

(LFI):"Let's face it!"

(CERT): computer recognition expression toolbox.

(FACS): is a detailed structurally based course of action for estimating all visually apparent facial movements.

(VIQ): mean Verbal IQ.

(PIQ): Performance IQ (PIQ).

(FSIQ): full scale IQ (FSIQ).

WASI: Web Assembly System Interface.

Conflict Of Interest

All authors declare no conflicts of interest.

Authors Contribution

Authors have equally participated and shared every item of the work.

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